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U. S. ARMY

Technical Memorandum 22-62

SUBJECTIVE REPORTS FROM SUBJECTS IN AN AIRCRAFT DETECTION STUDY:

A QUESTIONNAIRE ANALYSIS

William Wokoun

August 1962

OCMS Code 5210.12.128A0.01

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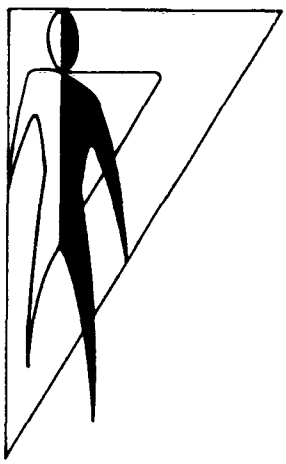
HUMAN ENGINEERING LABORATORIES



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(23) SUBJECTIVE REPORTS FROM GROUND OBSERVERS IN AN AIRCRAFT DETECTION STUDY. QUESTIONNAIRE ANALYSIS OF VARIABLES WHICH AFFECT EFFICIENCY. GENERAL COMMENTS FROM 22 SUBJECTS.

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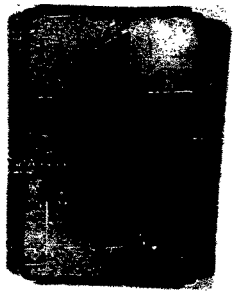

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(17) Descriptors

6619 UNIVERSITIES
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6756 VOCABULARY

X 0402. antiaircraft defense systems.
X 1684. detection.
0162. aircraft

ASPECT TERMS

0016 ACCEPTABILITY
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(18) Identifiers

GROUND OBSERVERS

OCMS Code 5210.12.128A0.01 Technical Memorandum 22-62

SUBJECTIVE REPORTS FROM SUBJECTS IN AN AIRCRAFT DETECTION STUDY:

A QUESTIONNAIRE ANALYSIS

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August 1962

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ABSTRACT

Questionnaires were administered to 22 subjects who had served as ground observers in an aircraft detection study conducted by another agency at White Sands Missile Range, New Mexico. This report summarizes the subjects' responses to questions about how they tried to detect aircraft and the variables which they felt had affected their efficiency in doing so.

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SUBJECTIVE REPORTS FROM SUBJECTS IN AN AIRCRAFT DETECTION STUDY:

A QUESTIONNAIRE ANALYSIS

INTRODUCTION

While several investigators have studied ground observers' effectiveness in detecting aircraft, little attention has been given to systematically assessing the subjects' feelings about their task and about the conditions which help them or hinder them in performing it. Yet such comments would be one useful guide in deciding such points as how long the duty cycle should be. The subjects' remarks should certainly be helpful in understanding and interpreting the data from such studies, and it seems possible that comments may yield valuable clues to how aircraft may be detected more effectively. User responses may also help to pinpoint some of the conditions which make it very difficult to detect aircraft. While some of this information may be inferred from detection ranges which have been recorded, other, unexpected bits of information may emerge from analysis of user comments. It seems rather obvious that, while experiments usually answer only the questions that their designers have thought to ask, the subjects' responses may add facts about other important points. This report summarizes what the subjects had to say. In preparing it, the writer has tried to preserve the flavor of the subjects' comments and to include as much as possible of what they said, even though some of their remarks may seem trivial.

However, a word of caution must also be added. This report presents opinions, not facts; and readers should constantly remind themselves that they are considering opinions, rather than facts. In the discussion which follows, we will be examining what the subjects say they did and what they say they thought about various conditions. For example, subjects may state that they were able to detect the targets much better under one condition than under some other condition, but this statement does not necessarily prove that they really did. It is conceivable that subjects might think they were doing well when they were actually performing rather poorly. Or the subjects may think they performed poorly when they were really doing a very effective job of finding the targets. The subjects, in other words, don't know all the answers. Sometimes the subjects disagree with each other. But some of the comments also suggest that there are times when subjects do know some interesting answers.

Rather than belaboring this point throughout the discussion of the questionnaire data, then, it will be assumed that readers understand the limitations of asking someone about his own performance.

The 22 subjects who were studied had taken part in an aircraft detection study that was conducted by another agency at White Sands Missile Range, New Mexico, in September 1961. They had been in the field for approximately two weeks. Three types of aircraft had been used in the study -- helicopters, propeller aircraft, and jet aircraft -- and each kind of aircraft had been flown over a dozen courses at two different altitudes. There had been approximately 100 aircraft passes during the study. The Human Engineering Laboratories were given an opportunity to submit a questionnaire, which the subjects completed at the end of the study.

QUESTIONNAIRE

The questionnaire, comprising 17 questions, was printed on one side of each of nine pages. There were two questions on each of the first eight pages, to allow adequate space for the subjects to write long answers if they cared to; the last question, which asked for any other comments the subjects would like to make, was on a page by itself to provide even more space. All of the subjects were able to fit their answers into the room allowed without any apparent difficulty.

The approach in writing the questionnaire was aimed at creating a folksy, down-to-earth atmosphere. It was intended that every subject should be able to understand every question easily, even though a few Spanish-speaking subjects might not have had a good command of English. Considerable care was used to frame rather rambling questions that did not suggest an answer. In addition, the wording was designed to elicit discussion insofar as possible, rather than giving the subjects questions which they could answer with a simple "Yes" or "No".

The questionnaire, and the brief paragraph of introduction which preceded it, is shown in Table 1.

TABLE 1

Questionnaire

You men have been out in the field watching planes for nearly two weeks. By this time, you've become experts on how the job can be done best. We now need your advice and comments to tell us what parts of the job are hard, and how this job can be made easier. Please answer the following questions carefully to tell us your opinions. If there are any things you have noticed that are not covered in the questions, please write them on the backs of these sheets.

1. On this kind of job -- trying to find aircraft -- did you think training was very important? For instance, did you think you did much better after a few days practice? How would you train a man to find aircraft?

2. Did you use any particular method for searching for the planes? If you did, what was it?

3. Did your way of searching change very much during the study? That is, did you search about the same way at the end of the study as at the beginning?

4. What kind of hints could you give to someone who had to look for aircraft?

5. Do you think there are any special qualifications a man should have to do this job well? What kinds of qualifications would you be looking for if you had to pick men for the job?

6. Were some of the aircraft easier to find than others were? Which of the aircraft -- jet, propeller or helicopter -- was easiest to detect? Which was hardest? Why?

7. What did you think was the best way to find aircraft -- by watching for them, or by listening for them, or both? Did you find the aircraft mostly by watching for them or by listening for them or both?

8. When you weren't supposed to have any warning that a plane was coming -- on surprise passes -- was there any way you could tell a plane was in the area? How?

9. When you weren't supposed to know a plane was coming, did you ever get a tip-off from watching other people at the sites? (Like by seeing something other subjects did or something the experimenters did?)

10. The planes you looked for flew on quite a few different "tracks". But did you ever think you could guess where the next plane would come from? How would you guess? And if you did guess, were you right?

11. Did you think it was easier to detect high-altitude aircraft or low-altitude aircraft? Was one altitude easier for all kinds of aircraft?

12. Some of the planes you saw had just plain sky behind them, but others had mountains or brush for background. Did this make it easier or harder for you to find some of the aircraft? Which was the easiest? Which was the hardest?

13. The planes you saw were painted differently. For example, some weren't painted, some were olive drab, some had bright orange markings, and so on. Did these colors make the planes easier or harder to find? What color would you use to camouflage a plane so it would be hard to see? What color would you use to make one easy to see (like a rescue plane, etc.)?

14. Did the sun make it harder for you to see the aircraft? Was noon better than early morning or late afternoon, or was it worse? Could you find planes when they came at you out of the sun?

15. Ignoring everything else, what time of day were you best at finding aircraft? Why weren't other times as good (Did you have to "warm up", or did you get tired, or what?)

16. How long do you think a man can work at detecting planes before he gets too tired to do a good job?

17. If you have any other comments, if there are any other things you've learned that you think we should know about, please write them on the backs of these sheets. Thank you for your help.

RESULTS AND DISCUSSION

1. Selection Criteria for Ground Observers

Question 5 asked the subjects what special qualifications a man needed to be an effective ground observer. All 22 subjects answered this question, although, because some subjects gave more than one answer, the frequencies which will be cited total more than 22. Most of the subjects -- 19 of the 22 -- agreed that some special qualifications were needed, although three indicated specifically that practically anyone could do the job. While there is general accord that good vision and good audition are needed, the remainder of the responses seem to become rather highly individualized. The complete catalog of answers to this question is shown in Table 2.

TABLE 2

Special Qualifications Needed	Number
Good vision	16
Good hearing	15
Willingness	5
Patience	4
Alertness	4
Liking for task	2
Maturity	1
Sharp reflexes	1
High IQ	1
Stamina	1
Observant	1
Quiet	1
"Hunts a lot"	1
"Doesn't drink (much or at all)"	1
No special qualifications needed	3

Surprisingly, many of the qualities mentioned infrequently do seem to have a common denominator. Willingness, patience, alertness, maturity -- terms such as these seem to point to the importance of a subject's motivation. These subjects may be saying that a subject can detect aircraft efficiently only if he believes the job is important and is trying to do his best. As one subject said, "Mostly what I would look for is a man he would try and not just goof off." While one might argue with this man's grammar, his argument is compelling. Certainly it seems that this is one area which should be stressed heavily during training.

2. Training Ground Observers

The first question asked subjects whether they felt training was needed for a man to detect aircraft effectively, and, if so, what kind of training should be given. A majority of the 22 subjects -- some 15 -- agreed that training was desirable or necessary, although it is interesting to note that four subjects felt it was not needed and one of the four was quite emphatic about his belief. The complete tabulation of responses is given in Table 3.

TABLE 3

Evaluation of Training	Number
Important	10
Some improvement after time on the job	4
May help	1
Not very important	3
Not needed	3
No!	1

Unfortunately, the subjects who felt no training was needed did not elaborate their answers enough to indicate why they felt no training was needed. Perhaps this feeling is based on an idea that nothing specific could be selected to train people about, or that such a menial task should not be dignified by training.

The largest number of subjects -- nine -- felt that training should be given on the job. This response may reflect their inability to isolate particular segments of the job that could be trained. Some subjects, however, did mention things that they thought should be stressed in training. There were five comments about teaching aircraft characteristics.

Two subjects suggested teaching subjects to differentiate the types of aircraft they would have to detect, although this ability has little bearing on finding aircraft in the first place. Two subjects suggested teaching people which levels (altitudes) they should look at, and one subject mentioned teaching how various aircraft fly (i.e., speed and direction). These comments would probably be impractical in a tactical situation, though, since observers would usually have to search extended envelopes of space to detect aircraft with any reasonable efficiency. Two men mentioned familiarizing with the terrain -- getting to know it, or studying the types of background aircraft would appear against. There were also suggestions centering about the observer himself. Two subjects recommended teaching subjects an efficient search method, while another two subjects stressed motivational aspects of performance (keeping alert; appreciating the importance of the job). Four subjects made no suggestions about what training should be given. One felt a simple explanation would be adequate. The remaining three observers felt, respectively, that training was "not a deciding factor," "not needed," and "impossible". In summary, much of the material which the subjects wrote in answering this part of the questionnaire makes no contribution to development of an effective training program, but two important points should be noted. First, it was recommended that subjects should be taught a search method. Also, the subjects mentioned that the man's motivation is important; this point is of interest in connection with the subjects' comments about qualifications needed for the task.

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3. Methods of Search, as described by Subjects

The second question asked the subjects whether they had used any particular method of searching for aircraft and, if so, what method they had used. Parenthetically, it should be noted that the subjects had been briefed about the most effective ways to search for aircraft at the beginning of the study. They had been told, in brief, that they should use vertical eye movements so they could avoid empty-field myopia by fixating on the horizon frequently. In the light of these instructions, the methods which were reported become particulary interesting. The subjects responded as shown in Table 4.

TABLE 4

Method of Search	Number
Vertical sweeps	3
Horizontal sweeps	5
Both vertical and horizontal sweeps	6
Original system (see below)	1
Random (no particular pattern)	5
No answer to question	2

Only two of the 22 subjects gave answers that showed explicit awareness of the need to fixate periodically. It is immediately apparent that the briefing given before the study had very little effect on the subjects' behavior. It would be helpful to know why the subjects did not search in the way they were told to, but their remarks do not provide enough information to say. Perhaps they felt that the system was too complicated, or that it was too much work, or even that it was not necessary since they could find aircraft anyway even if they did not look for them effectively. Another possibility worth considering is that the briefing may not have convinced the subjects that vertical scanning and frequent fixation would improve their performance. Future orientation programs for test subjects, or for troops who must detect aircraft in tactical situations, should place heavy stress on the importance of search method to assure that personnel understand not only what they are to do and how they are to do it, but also why they should do it.

Some of the comments given by subjects shed more light on the search systems that were used. One subject reported an original system in which he broke his 180^{o} sector into two or three sub-sectors. He then searched each of these sub-sectors by first focussing on a cloud, which served as a fixation point, then looking beyond it for aircraft. There is merit to such a system, if clouds are available, since it uses other fixation points besides the horizon. In addition, using sub-sectors and searching within each of

them may improve performance, provided that the man has enough terrain features to define sectors without missing part of the area he is supposed to be watching. Another subject said he usually looked at the middle of his 180° sector, shifting his gaze to the left and right "once in a while". This system was probably not very effective, although the subject may have achieved his detections mostly by using other cues. Two subjects stressed the importance of looking around, rather than staring: "Keep your eyes moving; don't stare." One said, "If you stare, you'll see something that isn't there -- or if you stare at an aircraft, you'll lose it." Two subjects mentioned the use of auditory cues: "Listen," or "Look toward the sound." Three subjects suggested that search should be concentrated on some areas, rather than on the entire area in general. One of the three rather unrealistically endorsed searching "typical altitudes for the kind of aircraft coming in", which would not prove feasible in most tactical situations. The second recommended watching "protected tracks a good pilot will try to fly", which will some times be quite practical. The third suggested looking for movement per se, and in this connection some observers have indeed reported that their eyes seem attracted to moving objects.

Closely allied to the search methods reported are the hints for detecting aircraft elicited by Question 4. Some of these hints parallel the material which has already been discussed under methods of search above, but the hints also included some novel twists which seem worth repeating.

Four of the hints dealt with detecting aircraft by listening for them. One subject recommended listening for the sound of aircraft, presumably in addition to watching for them. Another man neatly pinpointed a big disadvantage of listening without watching when he said, "Don't count on hearing an aircraft, as by that time range is limited." Still another subject pointed out rather perceptively that the sound of jets is deceptive, since it indicates a position where the jet was a few moments ago: "Look way ahead of the sound." Finally, one man recommended that subjects learn to differentiate the sounds of the aircraft from each other and from wind, trucks, generators, and the like. It seems notable that more of the hints dealt with sounds than with any other single thing. This frequency seems to show that the subjects considered sound an important clue.

Two men noted characteristics of the aircraft that help to identify them: reflections or glint ("flash") from the aircraft, and smoke trails. Another subject cautioned that subjects must be familiar with the maneuvers of birds, since "close birds look like far, big aircraft".

The sun seems to have presented some difficulties, and three men remarked about it. Apparently the best advice, if feasible, is, "Don't look at the sun." But if an observer has to look near the sun, "Shade your eyes and uncover slowly to prevent glare." Only one subject mentioned that it might be a good idea to wear sunglasses, which he felt would reduce "glair". From the relative infrequency of complaints, it would seem that the subjects did not consider the sun a major problem.

Among the miscellaneous hints, it has been suggested that observers must be familiar with terrain and fixed objects; that they should search "very high above the horizon sometimes", perhaps because the subject tended to ignore this part of the sky; that observers should get on a small rise if possible, because "even a couple of feet make a difference"; and that observers should not be heavy drinkers.

Question 3 asked whether method of search had changed during the course of the study. Responses are shown in Table 5 below.

TABLE 5

Amount of Change	Number
Much	8
Some	0
Not much	2
None	11
No answer to question	1

The distribution of frequencies is interesting, in that both extremes of change are reported even though almost no one reported moderate amounts of change. The majority of subjects -- 13 of the men -- said their method of search did not change, or did not change much. Another sizable group -- eight subjects -- said their method of search changed considerably. It seems likely that this bimodal distribution may reflect the men's involvement with their task: if they were interested in the task and worked at detecting aircraft, they may have discovered better ways to find the targets and adopted them; while, on the other hand, a man who searches in a cursory, half-hearted fashion would not have been very apt to develop any new systems for detecting the targets.

Four subjects wrote statements which indicated they were evolving their own systems for searching, although their statements were not detailed enough to really define the changes. One man wrote, "I learned to vary method according to weather. On calm and cloudy days, depended mostly on ears. On windy days, eyes more dependable." Another said he became more familiar with his surroundings. Two rather nebulous statements in this category were, "My pattern of search emerged from practice", and "Method became more complex and effective".

Two other subjects modified their search methods not so much to improve them as to make them work at all. One of these men remarked that at first he listened, but "it didn't work, so I had to look and listen both". The other said that he first looked only where he expected the aircraft to appear, but that he later looked high and low for bright objects and smoke trails.

The kind of change reported most frequently seems to reflect a sort of entropy. One man said he "got more relaxed", while another noted he was using a "slower rate of searching". One man became frankly tired of his task, although perhaps more proficient at it: "I became less alert -- boredom, and I knew what characteristics to look for." And another man just became tired: "Became more casual, because didn't tire as easily that way."

4. Visual vs. Auditory Cues

In Question 7, subjects were asked whether they felt it was more effective to detect aircraft by looking for them or by listening for them. Their answers to this question are summarized in Table 6.

TABLE 6

Cue Used	Number
Mostly vision	4
More vision than audition	3
Vision and audition about equal in importance	8
More audition than vision	1
Mostly audition	3
No answer to question	1

The remaining two subjects qualified their answers according to type of aircraft. Both agreed that jets must be detected primarily through visual cues. However, one subject said he detected helicopters and propeller aircraft mostly by hearing them, while the other subject said he detected these targets more by seeing them but also sometimes by hearing them.

Perhaps the most surprising fact revealed by this table is that relatively few subjects detected the targets through vision alone. One might have predicted that a brace of men who had nothing to do except watch a given sector of sky would have seen most targets before the aircraft got close enough to hear. It should be pointed out, too, that these men were tested under three conditions of warning. On one third of the trials, the subjects had been told when and where to look for the target. On another third of the trials, the men had been told that a target was in the area, but they did not know its course. During the remaining third of the trials, the

men had not been alerted, either to the fact that an aircraft was in the area or to its course. This third condition probably resembles a tactical situation more than the first two. If men are required to detect aircraft under such circumstances -- without any warning -- they may have to rely even more on auditory cues than they did during the present study.

The most frequent response -- that both vision and audition were used, about equally -- seems to represent a realistic compromise. Auditory cues have an important advantage in that they provide cues to direction, yet they can be perceived regardless of the direction that the man happens to be looking. However, visual cues also have an advantage: jet aircraft, as two of the men noted, can be seen at some distance, but the jets cannot be heard until they are nearly overhead. A good summary statement about the comparative merits of visual and auditory cues was given by one man: "Sound is good for backup, but no substitute for watching."

Three men observed that the relative usefulness of visual and auditory cues depends on weather. Two of these men remarked that, when the wind was blowing hard, it was better to watch instead of listening. Presumably the aircraft sounds were masked by wind noise. But vision must sometimes have been masked partially, too, because one man said that sound was a more important cue when the sky was cloudy.

One rather intriguing comment said, "I usually saw it when I knew where the aircraft would come from. When I had to wait a long time, usually heard it first." This statement suggests that it may be difficult to maintain effective visual search for prolonged times, as well as underlining the advantage that hearing is nondirectional. One wonders whether auditory cues may not be more compelling than visual ones -- i.e., that a man whose mind is wandering may be more apt to notice a faint sound than a small speck in the sky. This notion, however, is purely speculative.

5. Relative Difficulty of Aircraft Types

Question 6 asked the subjects which aircraft -- propeller, jet, or helicopter -- had been easiest to detect and which had seemed hardest to detect. The answers which they gave are summarized in Table 7.

TABLE 7

Kind of Aircraft	Number Rating: Easiest	Hardest
Helicopter	15	1
Propeller	2	
Jet	0	20
No answer to question	5	1

Most of the subjects -- 15 of the 17 who named an "easiest" aircraft type -- agreed that helicopters were the easiest sort of aircraft to detect. Their reasons for thinking so (some subjects gave no reason, while others gave more than one reason) are classified in Table 8.

TABLE 8

Helicopters easiest because:	Number
Slow	6
Can hear them far away	3
Sound direction not deceptive	2
Large silhouette	2
Sun glint	1
High altitude	1

Visual cues were one reason why helicopters seemed easy to find. Large silhouette and sun glint are obviously visual aspects of the helicopters. Mention of the helicopters' slowness implies, of course, that the subjects had more time to see or hear the helicopters. But the most important cues may have been auditory ones, since five different subjects mentioned either that helicopters can be heard from afar or that the sound direction was not deceptive. One man said that helicopters were easy because they usually flew higher than the other aircraft, although another man said the helicopters were hard because they could fly very low.

Two subjects considered propeller aircraft easiest to detect, and one of them explained that these aircraft can be heard at long distance and their sound can then be localized.

No subject rated the jet aircraft easiest to detect. A subject did say that the F-100 with afterburner was easy, since it left a trail of black smoke, but he considered the T-33 jet the hardest aircraft to detect. Practically all of the subjects -- 20 of the 21 who answered this part of the question -- said jets were the hardest to detect. As one man wrote, the jets were "fast, silent, and very thin presentation". A list of the men's reasons for saying jets were the most difficult aircraft is given in Table 9.

TABLE 9

Jets hardest because:	Number
Can't hear them	9
Fast	7
Slim (thin) silhouette	5
Sound direction deceptive	3
Extreme altitudes	1

It has already been mentioned that subjects considered it important to listen for aircraft, as well as watching for them. Yet Table 9 underscores even more heavily the extent to which these subjects relied on auditory cues. Nine men said jets were hard to detect because they could not hear the jets approaching. Another three men assumed this point and went on to add that the sound direction was misleading. Still another subject must have been listening for aircraft, because he said jets were hardest when approaching from "the direction the wind is coming from". In all, 13 of the 20 men who rated jets hardest thought the jets were hard because they were difficult to hear. Obviously, the auditory cues are an extremely important contribution to detection, and it seems probable that the subjects may have depended on auditory cues more than they realized. In addition, the jets' fast speeds gave the subjects less time to detect them. Reduced visual cues -- the jets' slim silhouettes -- were cited five times as making them more difficult to detect. However, two subjects mentioned that jets became very easy if they were leaving smoke trails.

6. Relative Difficulty of Detection vs. Altitudes

Question 11 asked whether it was easier to detect high-altitude aircraft or low-altitude aircraft. There was little agreement from one subject to another, as can be seen from Table 10.

TABLE 10

Kind of Aircraft	Easiest Altitude	
	High	Low
Helicopter	0	3
Propeller	1	3
Jet	3	1
Aircraft not specified	9	8
No answer to question - 1		

When talking about aircraft in general -- as most of the respondents did -- about the same number of subjects thought high altitudes were easiest as thought low altitudes were easiest. This finding might mean two things. First, it could be that there is no real difference between difficulty at high and low altitudes; perhaps, in other words, the subjects answered more or less randomly. On the other hand, the subjects may have been thinking about difficulty under various conditions which would make one altitude or the other preferable. Their comments are inadequate to clarify this point. Two subjects said high altitude was easier because it allowed better contrast between aircraft and its background. Another man said the high altitudes were easier on clear days. But one subject said high altitudes were harder because the faster aircraft flew at high altitudes. On the basis of these data, there is no good reason for saying that one altitude was more difficult to detect aircraft at than another altitude.

7. Relative Difficulty of Detection vs. Background

Question 12 pointed out that the aircraft which had flown during the study sometimes appeared against a sky background, while at other times it appeared against a mountain or terrain background. The subjects were asked which sort of background made it easier to detect aircraft. Their answers are categorized in Table 11.

TABLE 11

Easiest Background	Number
Sky	14
Terrain (any kind)	1
Terrain (mountain)	1
Terrain (brush)	1
Depends on aircraft type	3
No difference	1
No answer to question	1

Clearly, the subjects felt that detection was easiest when they could look at aircraft against a sky background. They said detections against sky were easier because the silhouette provided higher contrast, especially with dark aircraft, and because there was less clutter with irrelevant objects. One subject commented that detecting against a sky background became easier still if there were white clouds.

Only one man thought that terrain background allowed easier detection of all aircraft types. Two men thought that one kind of terrain was better than the other, although they disagreed on which type of terrain allowed best detection; one cited mountains as easiest and brush as hardest, while the other said brush was easiest and mountains were hardest.

Eleven of the people who thought sky background allowed best detection also compared mountains and brush. Their opinions were almost evenly divided, with six maintaining that mountains were harder than brush and five convinced that brush was harder than mountains. One man said mountains provided better contrast, while another claimed that mountains were a difficult background because they lowered the contrast. In most other cases, the men merely stated their preference without giving reasons for their choice. Some three men did note, however, that light-colored aircraft were detected the most easily of any aircraft seen against the terrain backgrounds.

Perhaps the best summary statement is that observers preferred the sky background and had no clear preference among the kinds of terrain backgrounds they had seen.

8. Relative Difficulty of Detection vs. Aircraft Color

Aircraft color was considered in Question 13, which asked the subjects whether the colors had affected target detection and, if so, which color had been easiest and which had been hardest to detect. The responses are shown in Table 12.

TABLE 12

Effect of Color	Number
Bright colors easier (i.e., orange)	10
Silver easier	2
No difference if aircraft far away	2
No difference	4
No answer to question	4

Thus about two-thirds of the subjects seemed convinced that some colors of aircraft were easier to detect than others. The majority of those who thought so believed that orange was easiest to detect. This finding does not necessarily conflict with the comments that color makes little or no difference with distant aircraft, because many of the aircraft in question may not have been detected until they were rather close.

Thirteen of the men also indicated the color they thought would best camouflage an aircraft. Seven suggested olive drab, although it is hard to decide whether this statement reflects personal belief, indoctrination, or simply induction after noting the color used on Army vehicles. Three men said white or light blue would be good camouflage colors, and two more endorsed light colors in general. One man recommended unpainted aluminum for camouflage.

9. Relative Difficulty of Detection vs. Sun Position

Question 14 attempted to determine the extent to which the sun had interfered with detection. From reading the responses which were given, one concludes that, although most subjects would prefer not to look at or near the sun, they were able to detect aircraft near it when they had to. Three men said the sun did not interfere with detection, and another three thought it did not interfere much. However, ten subjects noted that targets which were very close to the sun were hard to detect. One man commented that the sun actually helped him to detect aircraft, since aircraft near the sun often glinted or flashed. One index of discomfort from trying to look near the sun is that only one man mentioned that sun glasses help to reduce the "glair"; if glare had been really troublesome, more men would probably have suggested using sun glasses.

Some 17 subjects mentioned the time of day when they thought the sun interfered least with detection, but their comments seldom agreed. Four men said that sunlight and glare interfered most at noon, but another five men wrote that noon was the best time of day. One subject believed that late afternoon and early morning were bad, and his opinion was neatly countered by another subject who said these were the best parts of the day. Another man maintained that late afternoon shadows were harder, while a fellow subject said that afternoon was better. One man said morning was better, and another said noon and afternoon were best. It is difficult to imagine a more precise balance of opinion than these answers show. If sun position at one time of day really does lead to better detection performance than another, these subjects could not agree on what it is.

10. Time of Day When Detection Was Best

Question 15 asked subjects the time of day when they were most effective in detecting the targets. While this question resembles Question 14 superficially, Question 14 dealt specifically with the time of day when sun interference (if any) was least troublesome. The present question is much broader, since it encompasses any variables which subjects felt helped or hurt their performance at any time of day. The answers to this question, as listed in Table 13, show more uniformity than those discussed in the preceding section.

TABLE 13

Time of Day Preferred	Number
Morning	10
Noon	2
Afternoon	5
Early or late in the day	2
No difference	2
No answer to question	1

Nearly half of the subjects -- ten of the 21 who gave an answer -- thought they detected aircraft better in the morning. Only half as many men -- some five -- thought performance was best in the afternoon. The other answers were scattered: two men preferred noon, two thought they performed better early or late in the day, and two said there was no difference.

Some of the men also indicated why they named the time of day they had given, although not every man gave an answer and some gave more than one answer. By far the most frequent response was that the men -- six of them -- felt boredom and fatigue were less at the time they had named, which was usually morning. Three subjects chose their "best" time because that part of the day was not so bright; two of these thought they did better in the morning, but one preferred early or late times. Two men who had chosen morning as their most effective time named morning because of temperature: it was not so hot as the afternoon. Two subjects who said they did better in late morning or about noon thought they had to warm up to the task before they reached peak efficiency. Only two of the subjects who chose afternoon gave reasons; one said there were fewer shadows, and the other based his decision on the type of aircraft usually used. Finally, a man who thought he performed more effectively early or late in the day said contrast was better at these times.

11. Length of Watch and Detection Effectiveness

Question 16 asked the men to estimate how long an observer can look for aircraft before he becomes too tired to do an effective job. The answers to this question are given in Table 14.

TABLE 14

Length of Watch	Number
0 - 2 hours	4
2 - 4 hours	1
4 - 6 hours	4
6 - 8 hours	4
8 - 10 hours	1
Depends on other variables	4
Ambiguous	2
No response	2

These data do not seem to indicate any clear concensus. It is interesting to note that only one man said observers could continue watching effectively for more than eight hours. Also, there seems to be a discontinuity in the function between two and four hours, since only one subject gave an estimate in this range; however, this quirk may have arisen from sampling variations in the small sample which was studied.

Three of the four men who said permissible length of watch depends on other variables named the things they considered important. One man felt that the intertrial interval -- the time between aircraft passes -- was the important factor: "If slow and infrequent, effectiveness falls off." Another subject said that length of watch should be geared, in essence, to

the rigors of the task: "About two hours if standing constantly -- about ten hours if has mind on it and gets breaks." The third man said length of watch depends on the person: "On the average, with breaks, as long as needed."

Responses to this question are particularly interesting for the light they shed on some of the speculations about how time on duty would affect the man's effectiveness. The writer once considered the applicability in this situation of some of the data on radar-display monitoring, which would suggest that effective vigilance would begin to crumble after something like half an hour of performance. If there is any such effect, these men seem quite unaware of it. But readers must bear in mind that performance could have deteriorated considerably without the men knowing it. If it has not, it is worth knowing that these men seemed quite willing to work for protracted periods of time.

12. Miscellaneous Comments

Question 17 asked the subjects for any other comments they cared to contribute. Disappointingly few subjects -- only eight -- even attempted to coin any shimmering bits of wisdom. But some of the points which were mentioned may be interesting to readers.

Three men concentrated on ways that the subjects' performance could be improved. One stressed the importance of motivating and supervising the subjects. But even under the best of conditions, said another man, alertness is hard to maintain; he recommended that some sort of activity would help the subjects stay "sharp": "It's hard keeping on the ball while waiting. It would be easier to stay on the ball if you could walk around or sit." One man seemed troubled that the study focussed on detecting aircraft without identifying them, and he suggested use of field glasses to identify the airplanes. In addition, he felt it would be better to have a narrower field of view: "Too wide a scope limits your spotting ability." This dictum should be considered with caution, because it seems probable that limiting the field of view would severely restrict the man's ability to detect aircraft.

One subject said winged aircraft seemed easier to detect when they were in a crossing aspect. This remark is quite logical, since the cross-section the aircraft presents would then be increased. It is reasonable to assume that all three types of aircraft would probably be easier to detect on the crossing courses.

The other comments are evaluated as non-contributory or totally irrelevant.

13. The Role of Extraneous, Inadvertent, and Unintentional Cues in Detection

This final part of the Results and Discussion section will discuss three questions that aimed at finding out whether subjects had been able to simplify their tasks by using extraneous cues. While these remarks are specific to conditions of the study during which these subjects filled out their questionnaires, they do have some general interest, because they delineate some areas which must be controlled carefully in this sort of experimentation. There is general agreement among workers who have attempted to conduct aircraft detection studies that it is extremely difficult to coordinate such a complex operation without providing unintentional cues about what is going to happen and when it is going to happen. Nevertheless, if the results are to indicate realistically how subjects would perform under tactical conditions, such cues must be reduced to an absolute minimum.

Question 8 asked whether, on surprise passes, the subjects had noted any cues that told them an aircraft was in the area. Their answers (some subjects gave more than one) are shown in Table 15.

TABLE 15

Cues to Surprise Passes		Number
Sound		14
Various visual cues:		7
Sun glint	2	
Smoke trail	1	
Bright colors	1	
Movement	1	
General area	1	
Watching people	1	
Time elapsed since last trial		1
No surprise passes		2
No warning		1
Ambiguous answer, or no answer		3

Perhaps the most striking data in Table 15 are the two responses that "There weren't any surprise passes". In addition, one subject said he could predict when an aircraft pass would be made by keeping track of time. Another man said he watched the people at the test site: "Tension would relax -- people would move around more. And usually there was some talking." It seems quite clear that at least some of the subjects knew when some of the surprise trials were coming.

The responses about visual and auditory cues are more difficult to interpret. The general tenor of these comments suggests that the subjects may be telling us the first thing that caused them to detect an aircraft, without necessarily suggesting that they had been forewarned. Without having an opportunity to interview these men, it seems wisest not to read too much into these ambiguous remarks.

Question 9 asked more specifically whether subjects had been alerted to surprise passes by anything the other subjects or the experimenters did. Table 16 summarizes the answers to this question.

TABLE 16

Kind of Cue		Number
Visual:		9
Watching other subjects	6	
Watching experimenters	2	
Watching both subjects and experimenters	1	
Auditory:		3
Heard subjects	2	
Heard experimenters	1	
No cues noted		8
No answer to question		3

A sizable minority of the subjects -- nine of the 19 who answered this question -- said they had got cues from watching what the other subjects and the experimenters did. It is apparent that more of these cues came from watching subjects than from watching experimenters; this result would be expected, since there were more subjects than experimenters anyhow, and the experimenters had been cautioned to avoid giving cues. The most frequently-noted cue from another subject was his behavior after he had detected an aircraft: he sat down, he put his pushbutton box on the ground, he relaxed, or he moved away from his post. One subject, though, seems to have received somewhat earlier warning, for he said he was alerted by seeing another subject "looking hard". Cues from the experimenters were similar; two subjects noticed that they were looking around, as if trying to see an aircraft.

Some subjects also reported auditory cues. Two reported only auditory cues, while a third reported both visual and auditory cues. One man said he heard a subject yell. Another said he heard voices on the field telephones. A third said he heard the click of pushbuttons.

In answering the second part of Question 9, 18 subjects gave the frequency with which they had noted cues on surprise passes. The largest number of them -- eight men -- said they had never received cues. Five said they had noticed unintentional cues once or twice, and three said they had observed cues several times. One man said he had seen cues "many times", and another said he had discerned a cue on each and every surprise trial. Because the subjects tended to estimate frequency with indefinite words like "several" or "many", it is difficult to boil the responses down to numbers. Most subjects said, though, that they had received inadvertent cues on no more than a few trials; but two subjects said they had often noticed such cues. An obvious implication for future studies is that cues should be minimized by placing subjects where they cannot see other subjects.

The aircraft schedule itself -- times, courses, altitudes, and the like -- may provide cues if there are predictable regularities in it. Question 10 asked the subjects whether they had tried to guess the course which would be used on the next trial and, if they had, whether they had been able to guess accurately. One subject did not answer this question. Another five subjects said they had never tried to guess which course would be used next -- rather surprising when one considers the amount of unoccupied time these men had spent at the test site. The majority of the men -- 16 of the 21 who answered this question -- said they had tried to guess on at least some of the trials. Half of this group -- eight men -- said their guesses were usually wrong. Another three said they sometimes guessed correctly, as they might well be expected

to do, even if they guessed randomly. Another five subjects, however, said they were usually right. Their guesses were based on the direction in which the previous aircraft had left (two subjects), knowledge of where the various courses began (two subjects), and the "fact" that altitudes "usually alternated" (one subject). In trying to interpret these comments, one begins to wonder who is out-guessing whom. The aircraft schedule was presumably prepared in a random fashion, so subjects should not have been able to make consistently correct predictions unless there were systematic progressions that the experimenters were not aware of. These five responses, then, seem to pose an intriguing enigma: would these predictive systems really have worked, at least during portions of the schedule, or do gamblers hate to admit they lost?

SUMMARY

1. Questionnaires were administered to 22 subjects who had served as ground observers in an aircraft detection study. This report discusses their responses to questions about how they tried to detect aircraft and variables which they felt had affected their efficiency in doing so.

2. The subjects felt that good vision and good hearing were the prime requisites for a ground observer. They also stressed the importance of the observer's motivation.

3. A majority of subjects felt that training for the job was desirable or necessary. Their suggestions for training were discussed.

4. Although the subjects had been instructed to use vertical search sweeps with frequent fixations, most subjects said they used other methods instead.

5. Search method seemed either to remain the same throughout the study or to change considerably. The most frequent change appeared to be relaxing or easing up.

6. Relatively few subjects detected the targets through vision alone; most frequently, subjects detected aircraft using both visual and auditory cues, and they stressed that neither is really effective by itself.

7. Most men considered the jets the most difficult targets to detect, and most agreed that the helicopters were the easiest. The reasons they gave for these choices were discussed.

8. The subjects were almost evenly divided on whether it is easier to detect high-altitude or low-altitude aircraft.

9. The majority of subjects said that it is easier to detect aircraft against a sky background than against a terrain (mountain or brush) background.

10. About two-thirds of the men said they thought colored (orange) aircraft were easier to detect than others.

11. If sun position at one time of day really does lead to better detection performance than another, the subjects could not agree on which time is best.

12. About half of the subjects thought they detected aircraft better in the morning; the remainder of the answers were scattered.

13. There was no obvious concensus about the length of time a man can search for aircraft before his efficiency becomes degraded.

14. Several questions investigated the role of inadvertent cues in this study. There is good evidence that at least some subjects did get forewarning from various kinds of cues, particularly from monitoring the behavior of other personnel at the test site. In addition, two men claimed that they had usually or always been able to guess the course which would be flown next.

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Technical Memorandum 22-62
By William Wokoun August 1962

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